

the equations can be solved; some special examples are given. For the sake of greater intelligibility, I have included an historical account of previous theories of plane plates and shells, a description of the method of the present paper, and a summary recapitulating the chief physical results.

II. "True Teeth in the young *Ornithorhynchus paradoxus*." By EDWARD B. POULTON, M.A., F.L.S., of Jesus and Keble Colleges, Oxford. Communicated by W. K. PARKER, F.R.S. Received January 26, 1888.

For the purpose of continuing some recent work upon various epidermic structures in *Ornithorhynchus*, Dr. Parker very kindly placed his most valuable material at my disposal. Among other things was a series of consecutive vertical transverse sections through the head of a young individual, about 8·3 decimetres long, when in the curled-up attitude in which it had been received, and which was fixed by the spirit. In this specimen only the larger hairs had appeared above the surface of the skin.

The sections had been prepared for Dr. Parker by his son, Professor W. Newton Parker, of Cardiff, and although intended for the investigation of morphological points in connexion with the development and structure of the skull, many of them were in every way adapted for minute histological investigation. Examining these sections I found that large and apparently typical mammalian teeth were developing in the subepithelial tissues on each side of the roof of the mouth. I at once communicated with Dr. Parker, telling him of the discovery, and enquiring whether he had any objection to the publication of the fact. Dr. Parker replied, and urged me to at once communicate the discovery to the Royal Society, at the same time offering me material in the most free and generous manner for the further investigation of the dental structures in *Ornithorhynchus* and in *Echidna* (if present in the latter). When it is remembered that Dr. Parker had put the sections aside for a time in consequence of the press of other work, intending soon to make use of them for the investigation of the skull, it will be seen at once that my association with this discovery is purely accidental, and that I have been treated in an extremely generous spirit.

As the lower jaw was not included in the sections, I cannot yet state that teeth are present in it, but there is little doubt that this is the case.\* Teeth were present in the upper jaw, in thirty sections through the head, and of these all, except the nine anterior sections, included some part of the eye. The teeth probably represent some

\* I have since found that teeth are present in the lower jaw.—Feb. 6, 1888.

part of the molar series in the higher mammals. Examining the sections from the front backwards, the first tooth appeared a little behind the anterior margin of the epithelial elevation, which appears to represent the developing horny plate which in the adult is the functional representative of true teeth. The teeth seem to form a tolerably straight line, extending internally to the horny plates, and passing considerably further backwards than the latter.\* Owing to imperfections in this part of some of the sections, I could not determine the exact number of teeth with accuracy, but they appear to be five or six in number on each side.† The most anterior of these is of a different character from the others, and is apparently separated from them by an interval which is longer than in other cases. This anterior tooth is the most developed, and its apex extends so far towards the surface that it nearly touches the epithelium. It is a pointed cylindrical tooth, directed vertically downwards. The four‡ or five posterior teeth are of uniform shape. Their structure, appearance, and relation to the surface are shown in fig. 1 ( $\times 40$ ). The two chief cusps of each of these broad teeth arise from the inner side of the surface.§

The structure of the enamel-cap is entirely normal, except that capillaries are certainly present in the middle membrane, intruding from without. The inner layer of long enamel cells is very distinct (see figure). No enamel is formed from them at this stage, except probably in the case of the anterior tooth.§ The dentine is quite normal in appearance and formation in the posterior teeth, except that the striation due to dentinal tubules can only be made out beneath the apex, but this may be due to the condition of the specimen or to method of preparation.|| The inner part of the dentine stains faintly in carmine, and shows the striation; the outer part does not stain, and appears homogeneous. The dentine of the anterior teeth is much thicker, and is not of normal character|| in its inner part, its outer part resembling that of the other teeth.

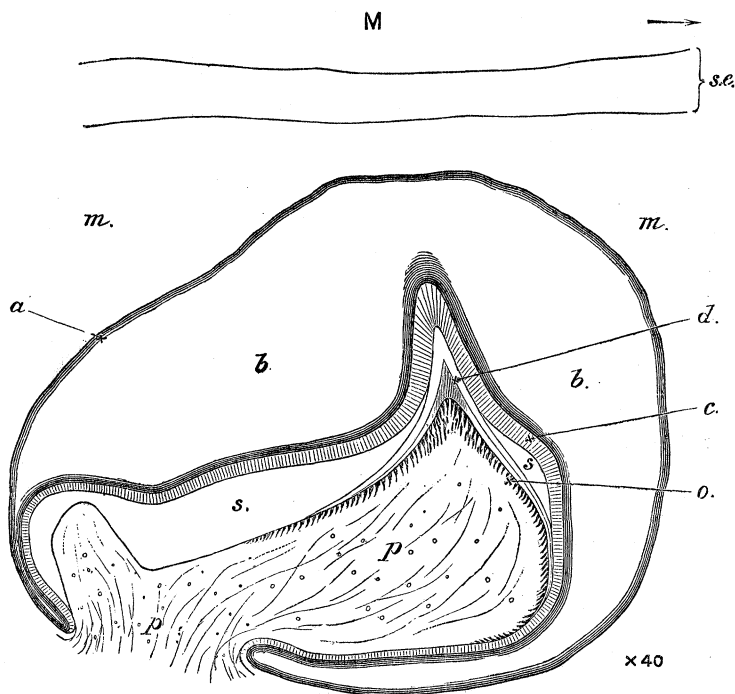
\* In the lower jaw the teeth appear to lie exactly beneath the developing plate. This may be the case in the upper jaw also, for the epithelium was in a damaged condition, and I may have been mistaken in my first identification of the undeveloped horny plate. Comparison with a skull of the same age strongly supports this conclusion.—Feb. 6, 1888.

† I have since found that the teeth are fewer in number, probably three being present upon each side of each jaw. The two posterior teeth have many cusps, and the two largest of these looked like separate teeth in sections. The true shape has been shown by a dissected preparation of the lower jaw.—Feb. 6, 1888.

‡ In the lower jaw the two chief cusps arise from the *outer* side of the teeth.—Feb. 6, 1888.

§ Recently prepared sections, made in order to decide this point, have shown that enamel is certainly present.—Feb. 6, 1888.

|| Recently prepared sections have shown that the dentine is of the usual struc-



There can be no doubt that these structures are characteristic Mammalian teeth, and their appearance harmonises well with the results of Hertwig's researches on the structure and development of Placoid scales. His researches indicate that the Mammalian teeth are probably in a more ancestral condition than any other organ possessed by the adult. They must have been derived at one time from Prototherian ancestors, and yet existing Prototheria were not known to possess them. Their occurrence in *Ornithorhynchus*, therefore, supplies the step just where it is wanted, and the fact that they are practically identical with the teeth of higher mammals is a further indication of the ancestral nature of these structures, for other higher mammalian features represented in the Prototheria are profoundly modified in the latter.

Dr. Parker has very kindly placed his material at my disposal, so that I propose to at once investigate, and shall shortly publish a paper upon, the nature of the teeth in the lower jaw of *Ornithorhynchus* and in *Echidna* (for it is in every way probable that they will be found in this genus also). I also intend to work at the mature organism,

ture, although in some sections it has been rendered apparently homogeneous, probably by some method of preparation.—Feb. 6, 1888.

for it seems probable that such large tooth-rudiments may be traceable in later stages.

In this investigation, the few points of uncertainty as to the minute structure of some of the tissues will in all probability be settled satisfactorily.\*

#### DESCRIPTION OF FIGURE. $\times 40$ .

The arrow points towards the middle line of the mouth.

- M. Mouth.
- s, e. Superficial epithelium of oral cavity.
- m. Sub-epithelial tissues forming tooth-sac immediately outside enamel-cap.
- a. Outer membrane of enamel-cap.
- b. Middle membrane of enamel-cap.
- c. Inner membrane of enamel-cap; the enamel cells. The dark layer just external to the enamel cells represents the stratum intermedium of Hannover.
- d. The dentine, of which the inner part stains faintly and shows the delicate dentinal tubes.
- s. Space caused by shrinkage between enamel cells and the outer part of the tooth rudiment.
- p. Tooth papilla.
- o. The odontoblasts forming the superficial layer of the papilla.

### III. "On the Relative Densities of Hydrogen and Oxygen. Preliminary Notice." By Lord RAYLEIGH, Sec. R.S., Professor of Natural Philosophy in the Royal Institution. Received February 2, 1888.

The appearance of Professor Cooke's important memoir upon the atomic weights of hydrogen and oxygen† induces me to communicate to the Royal Society a notice of the results that I have obtained with respect to the relative *densities* of these gases. My motive for undertaking this investigation, planned in 1882,‡ was the same as that which animated Professor Cooke, namely, the desire to examine whether the relative atomic weights of the two bodies really deviated from the simple ratio 1 : 16, demanded by Prout's Law. For this purpose a knowledge of the densities is not of itself sufficient; but it appeared to me that the other factor involved, viz., the relative atomic *volumes* of the two gases, could be measured with great accuracy by eudiometric methods, and I was aware that Mr. Scott had in view a redetermination of this number, since in great part carried out.§ If both investigations are

\* This appears to have been already the case.—Feb. 6, 1888.

† "The Relative Values of the Atomic Weights of Hydrogen and Oxygen," by J. P. Cooke and T. W. Richards, 'Amer. Acad. Proc.,' vol. 23, 1887.

‡ Address to Section A, British Association 'Report,' 1882.

§ "On the Composition of Water by Volume," by A. Scott, 'Roy. Soc. Proc.,' June 16, 1887 (vol. 42, p. 396).



S.C.

III.

*ML.*

*a*

6

 $d.$ 

6.

*C.*

O.

S.

$\mathcal{P}$

$p$

x 40